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Radiographic Perioperative Evaluation of Pancreatic Transplant

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Patient Presentation

- 41 y.o. female with Type I diabetes mellitus for 24 years
  - Difficulty controlling glucose levels
  - Frequent and severe episodes of metabolic complications (i.e. DKA)
  - Peripheral neuropathy
  - Chronic renal failure (diabetic nephropathy) requiring dialysis

Treatment Options

- Optimize insulin control
  - Alter type of insulin regimen used
  - Insulin pump for improved insulin dose control
- Treat/prevent secondary complications
  - Nephropathy: Strict BP control (ACEI); dialysis
  - Retinopathy: Photocoagulation
  - Neuropathy: Pain management
- PANCREAS TRANSPLANT

Selection Criteria at BIDMC

- Anyone with uncontrolled or poorly controlled Type I diabetes and at least one of the following:
  - HbA1C persistently >7%
  - Proliferative retinopathy
  - Diabetic Nephropathy diagnosed by biopsy or proteinuria
  - Autonomic or peripheral neuropathy
  - Frequent and severe metabolic crises resulting in hospitalization

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BIDMC Contraindications

- Age must be between 13 and 65
- BMI > 35
- Type 2 diabetes mellitus
- CV disease
  - Recent MI
  - Significant CAD
  - CHF
  - Severe peripheral vascular disease with ischemia of at least one limb
- Cancer diagnosis within 5 years
- Possible difficulty with compliance to rigorous post operative medication regime

How common is this procedure?

- The first clinical pancreas transplant was done with a simultaneous kidney transplant at the University of Minnesota on 12/16/66.
- Total of 14,000 pancreas worldwide
- Current annual average around 1000

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Surgical Transplant Options

- Simultaneous Pancreas Kidney (SPK)
- Sequential Pancreas after Kidney (PAK)
- Living Donor Kidney Transplant Alone (LDKTA) + PAK
- Pancreas Transplantation Alone (PTA)

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Transplant procedure: Exocrine Drainage Methods

- Cutaneous graft duodenostomy
  - Metabolic acidosis (loss of bicarbonate)
- Open duct free intraperitoneal drainage
  - Severe peritonitis & amylase ascites
- Polymer duct injection and occlusion
  - Severe pancreatitis
- Enterovesical drainage
  - Chronic cystitis, reflux pancreatitis, recurrent UTI, metabolic acidosis, urethritis
- **Enteric drainage: Side-to-side duodenoenterostomy currently preferred**

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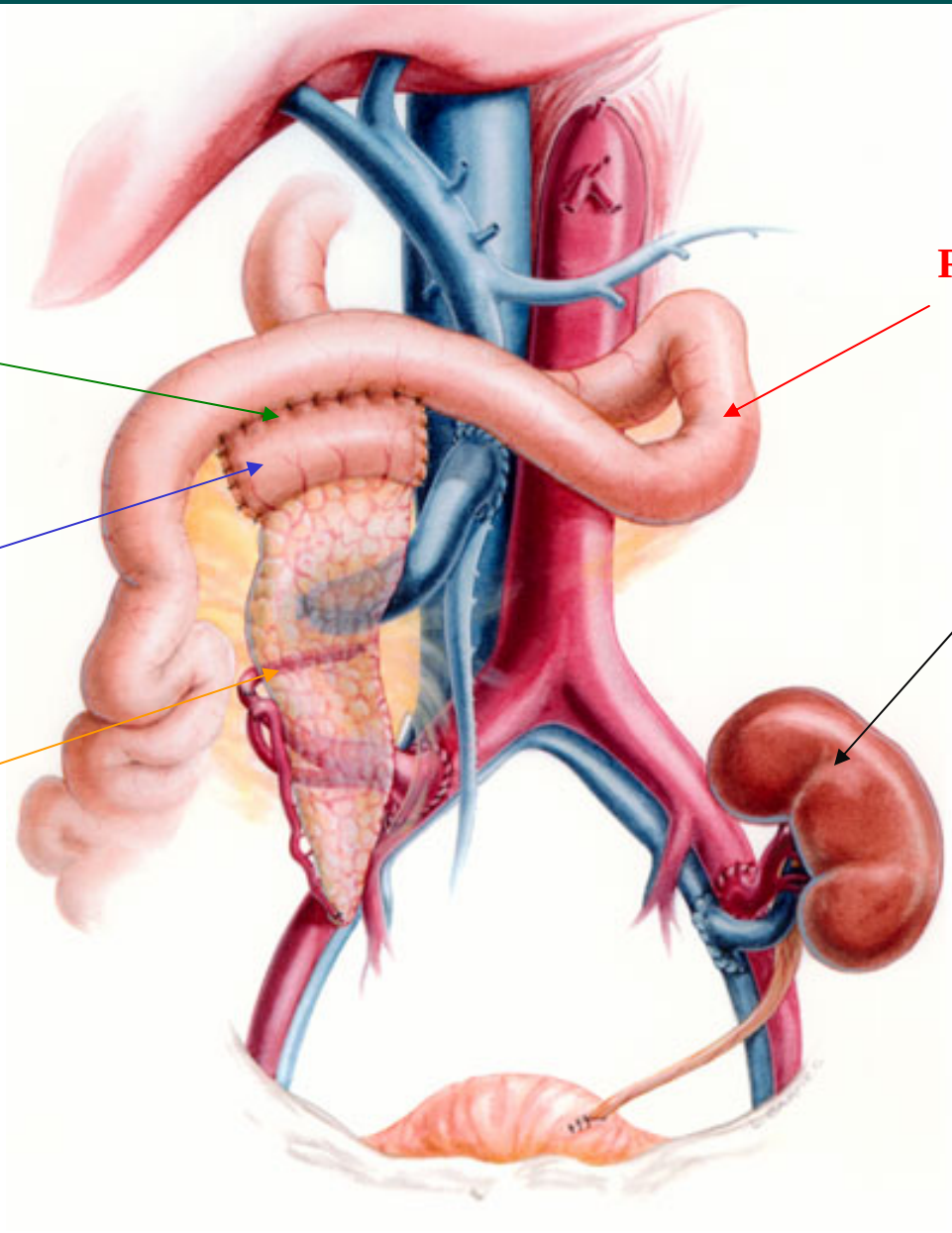
Side-to-side Duodenoenterostomy



http://www.clevelandclinic.org/urology/news/misc/images/vol8jx.jpg

Vascular Anastamoses

- Arterial anastamosis: RLQ using donor splenic artery and SMA to recipient common iliac via Y-graft
- Venous anastamosis
  - Portal:
    - Donor portal vein to recipient superior mesenteric vein
    - Physiologic, but technically very challenging
  - Systemic:
    - Donor portal vein to recipient common iliac vein
    - Technically less challenging
    - Possible complications: Hyperinsulinemia resulting in dyslipidemia, accelerated atherosclerosis, and insulin resistance
  - Retrospective study indicating graft survival higher in portal (79%) vs systemic (65%) anastomosis

Philosophe B et al. Annals of Surgery (2001), Vol. 234 (5), 689-696

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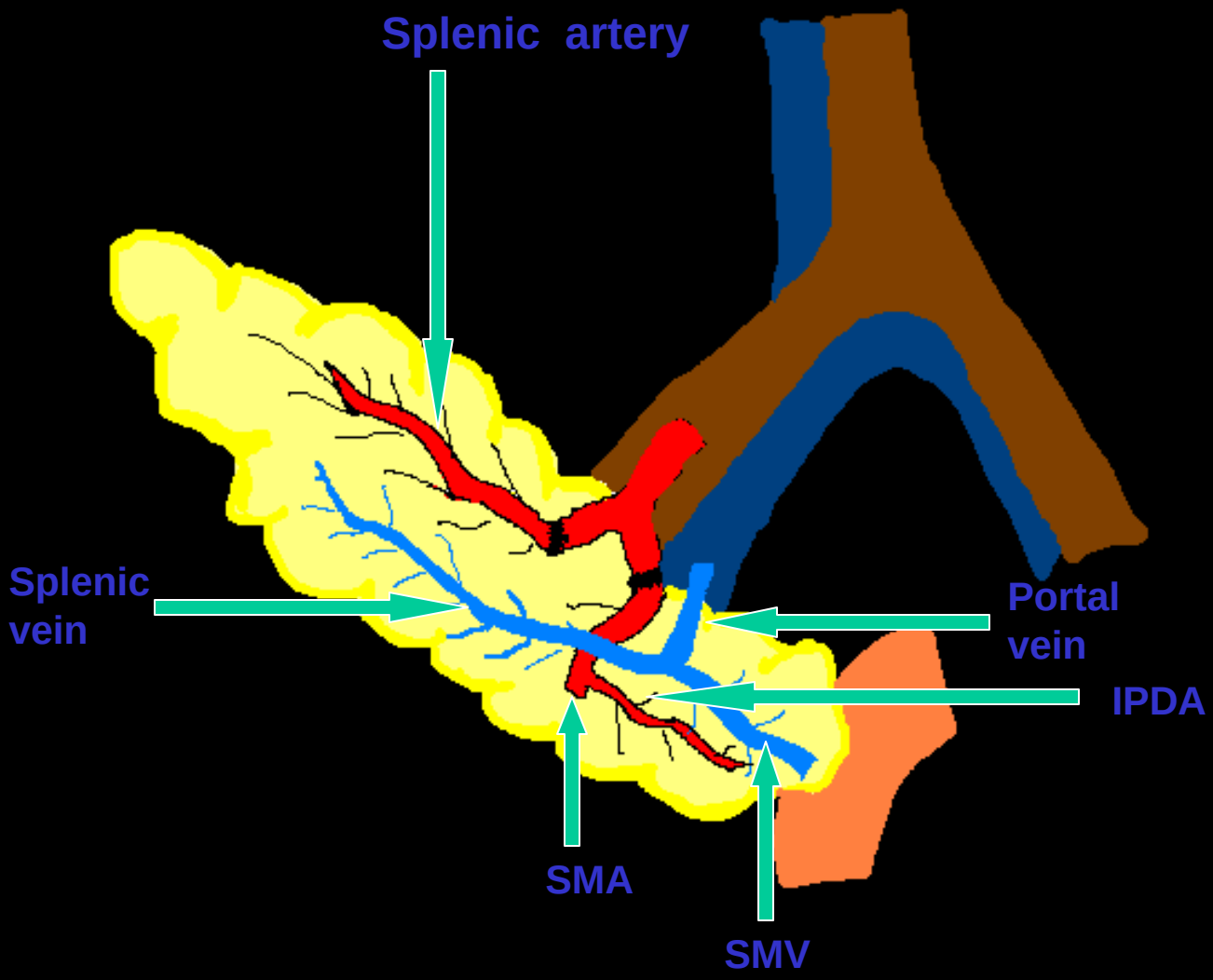
Vascular Anatomy



Courtesy of Dr. Tkacz and Dr. Kruskal

Causes for Graft Loss

- Technical Failure: 9%
  - Vascular thrombosis (Most common complication)
  - Anastomotic leak
  - Infection
  - Pancreatitis
  - Bleeding
- Allograft Rejection: 3-16% at 1 yr

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HOW CAN WE IDENTIFY THESE PROBLEMS?

RADIOLOGY

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Imaging technique: Ultrasound

- Advantages
  - Very good at assessing vasculature using spectral and color flow doppler
  - No radiation
  - Can identify peri-pancreatic fluid collections
- Limitations
  - Pancreas does not have discrete capsule resulting in difficulty visualizing pancreas among bowel loops
  - Etiology for fluid collections cannot be delineated

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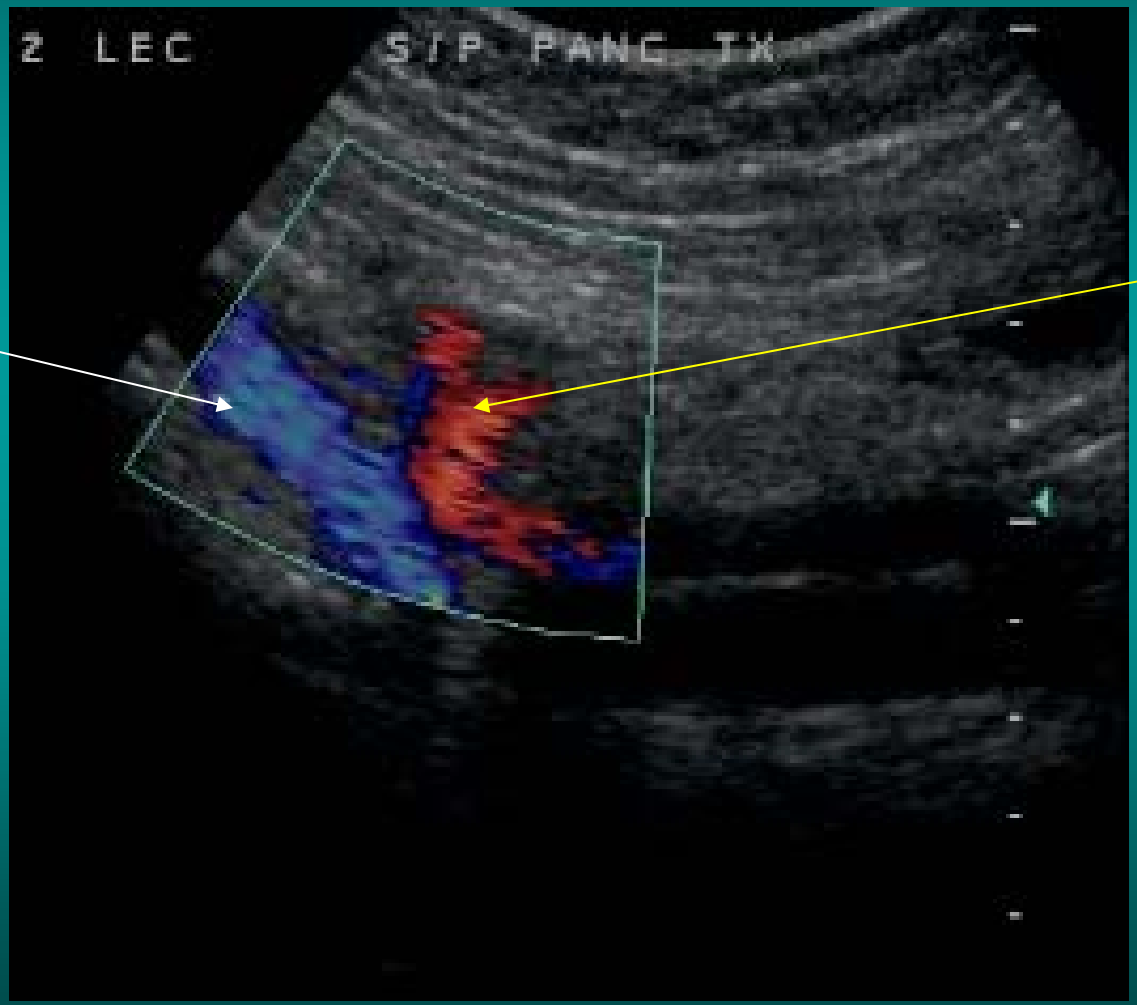
Patent Pancreatic Transplant Vessels by Color Flow Doppler



Images Courtesy of Dr. Tkacz and Dr. Kruskal

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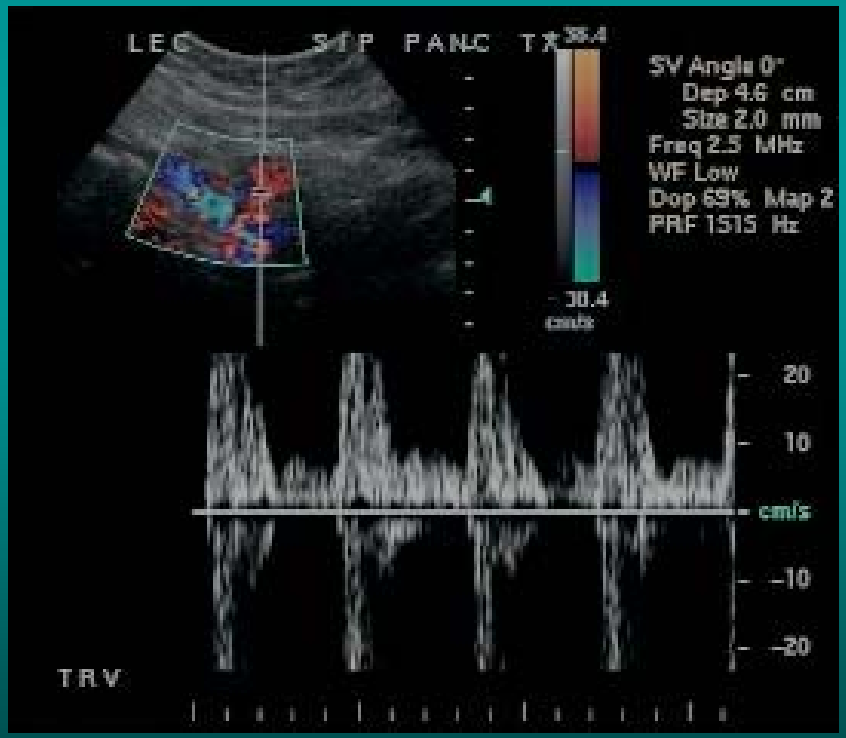
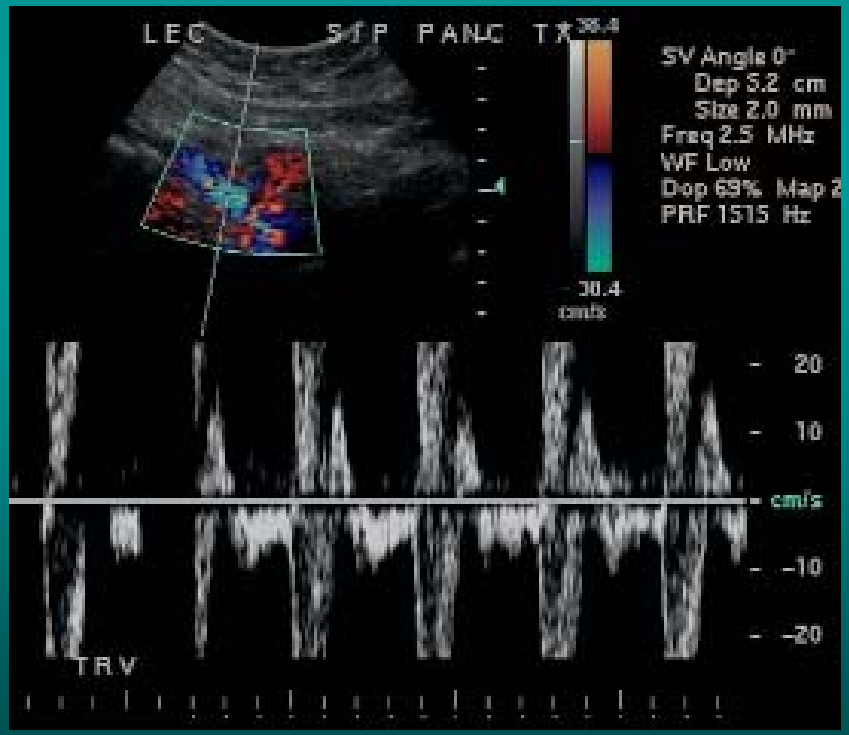
Patent Pancreatic Transplant Vessels by Spectral and Color Flow Doppler

Good Arterial and Venous Wave Pattern





Images Courtesy of Dr. Tkacz and Dr. Kruskal

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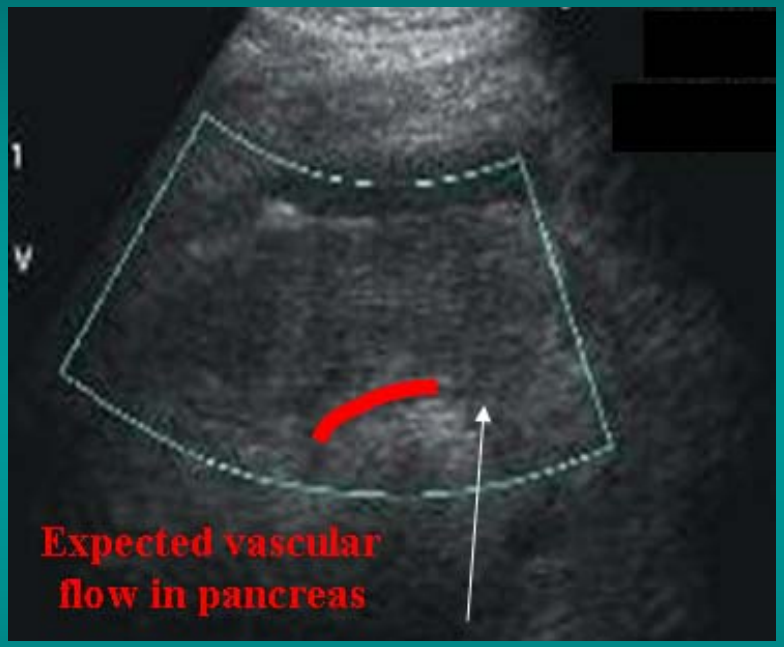
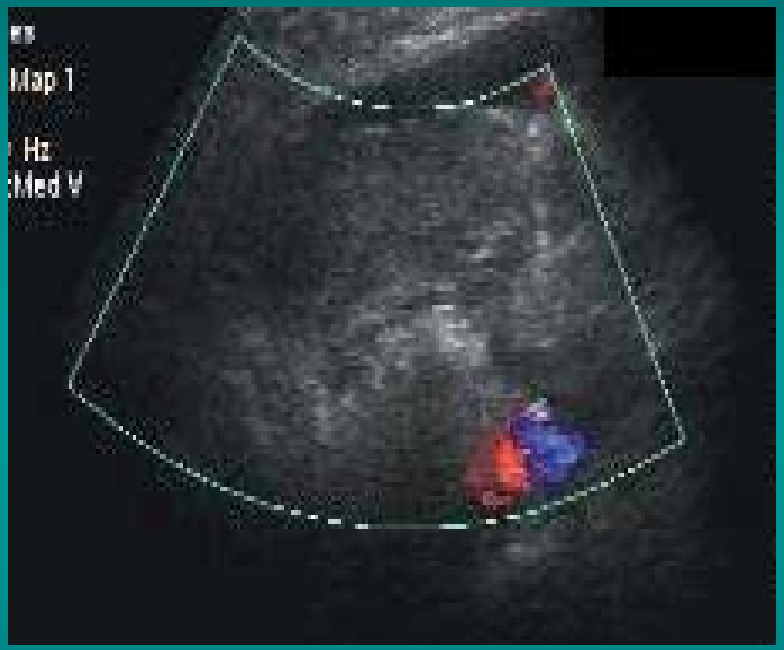
US Vascular Evaluation #1

Patient with lower abdominal pain and rising glucose levels



Proximal vessel entering pancreas



Lack of vascular flow in pancreas by color doppler

Diagnosis: Arterial Thrombosis
Resulted in allograft pancreatectomy

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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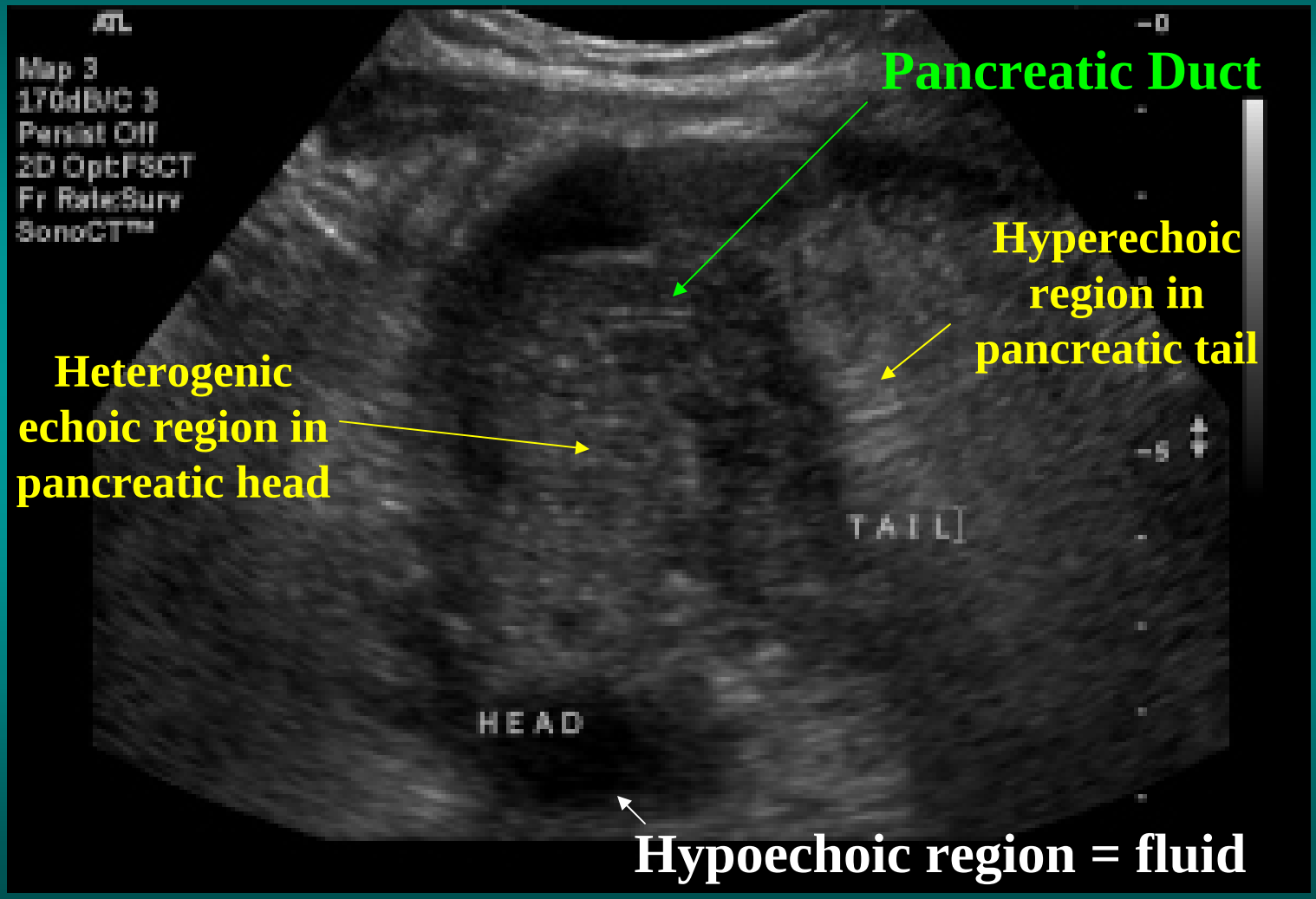
US Vascular Evaluation #2

Patient with rising glucose levels



Images Courtesy of Dr. Tkacz and Dr. Kruskal

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US Vascular Evaluation #2

Spectral flow analysis showed decreased arterial flow to pancreatic head

Diagnosis: Pancreatic Head Thrombosis

Resulted in pancreatic head resection

Images Courtesy of Dr. Tkacz and Dr. Kruskal

Imaging Technique: CT

- Advantages
  - Effective enteric anastomotic leak detection via oral contrast extravasation
  - Detection and evaluation of fluid collections
    - Hematoma, ascites, pseudocysts, abscess, or urinoma
  - Evaluate complications of pancreatitis
    - Abscess, pseudocyst, adjacent tissue involvement
  - Vascular compromise evaluation can be done with contrast
  - CT guided drainage of pseudocysts, abscess, fluid
- Disadvantages
  - Severe renal failure precludes IV contrast
  - Often difficult to differentiate fluid collections and changes of pancreas morphology
  - Largest radiation dose

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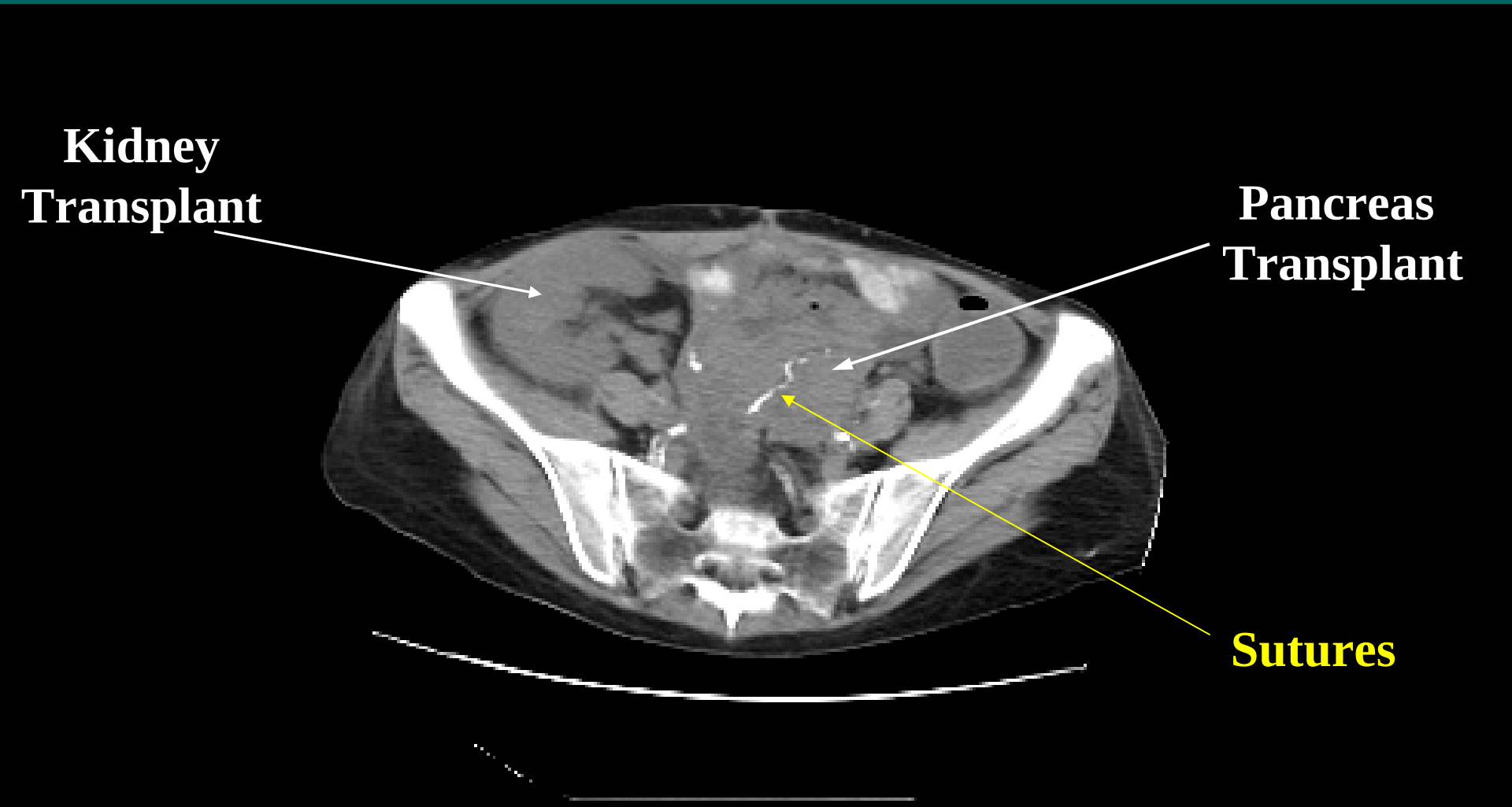
Where is that pancreas?



Images Courtesy of Dr. Tkacz and Dr. Kruskal

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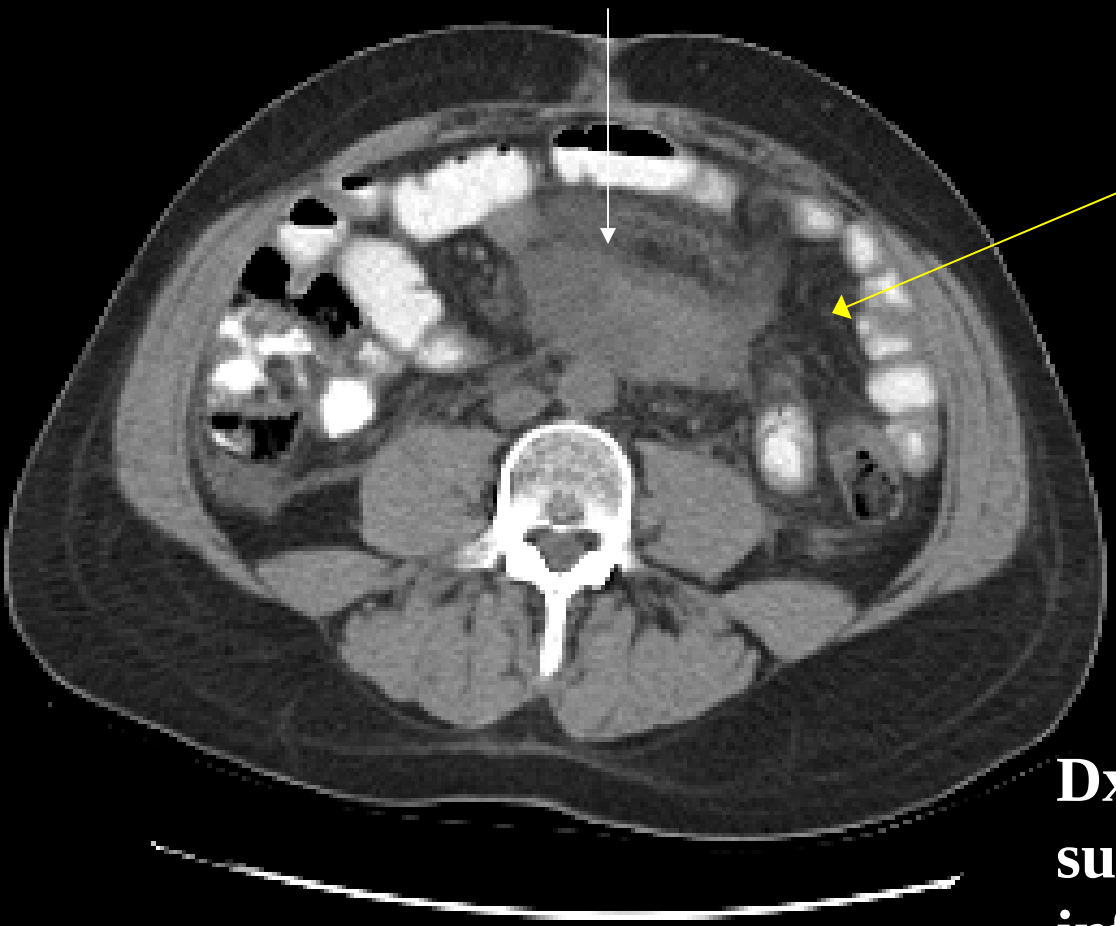
Common Findings Post-Transplant

Low attenuation pancreatic transplant



dDx:
1) Pancreatitis
2) Vascular Occlusion
3) Rejection

Peri-pancreatic fluid

dDx:
1) Edema
2) Hematoma
3) Ascites
4) Pseudocyst
5) Abscess
6) Urinoma

Dx: Pancreatic Rejection with surrounding edema from inflammation

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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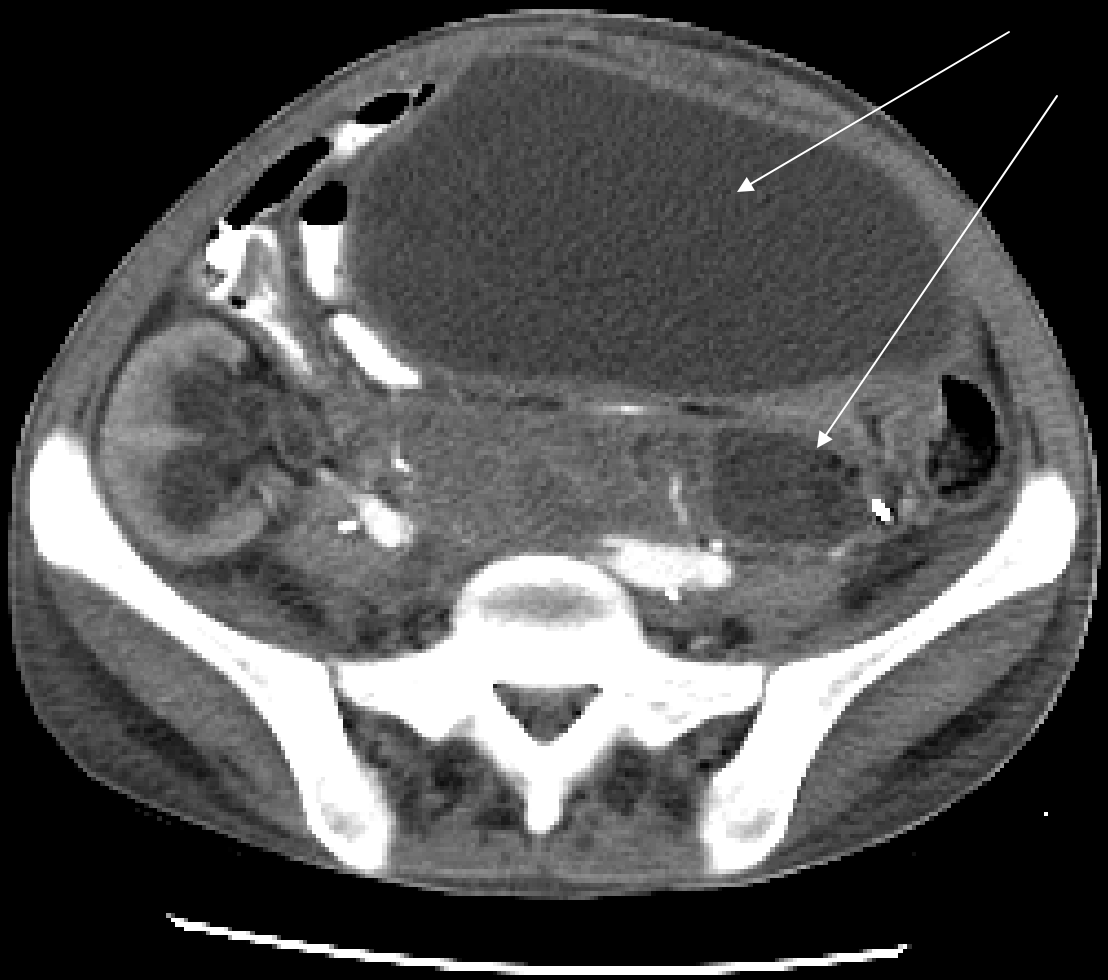
Abdominal Distension and ? Bowel Obstruction



Multiple Large Loculated Hypodense Regions with HU of Fluid

dDx:
1) Pseudocyst
2) Lymphocele
3) Seroma
4) Abscess

Dx: Pseudocyst

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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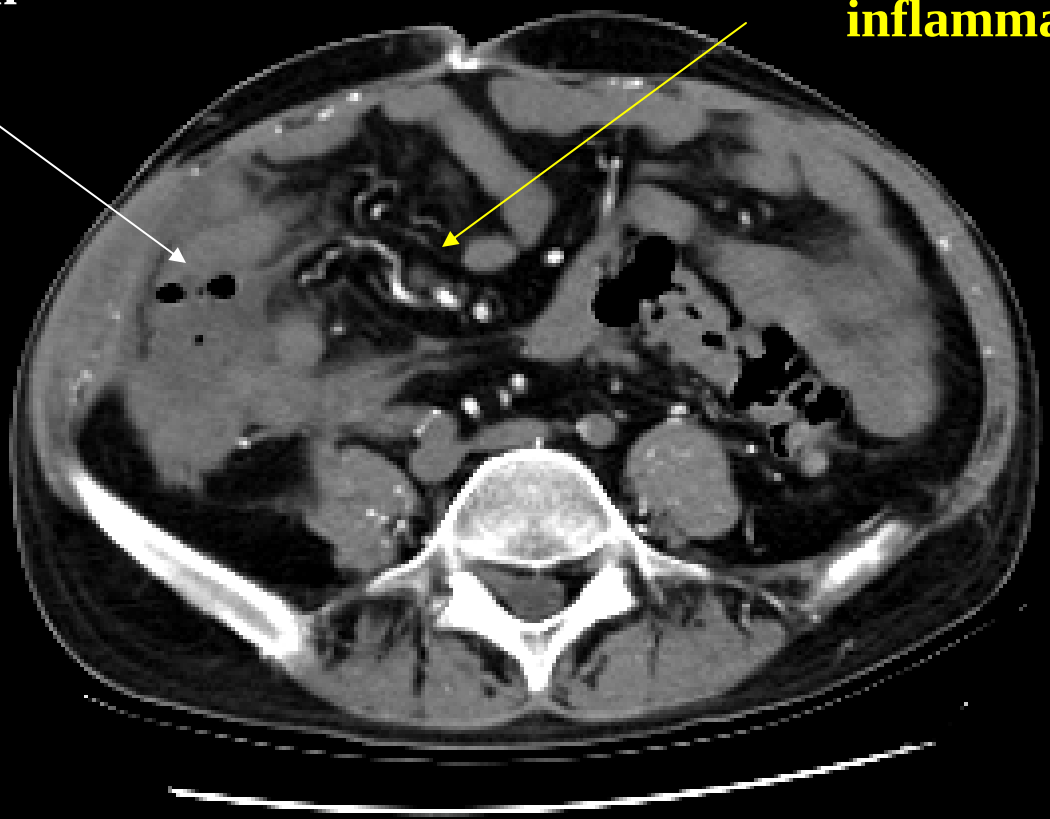
Fever and Abdominal Pain

Fluid collection with air

Stranding and fluid indicating inflammatory changes



dDx:
1) Abscess
2) Pseudocyst
3) Cyst

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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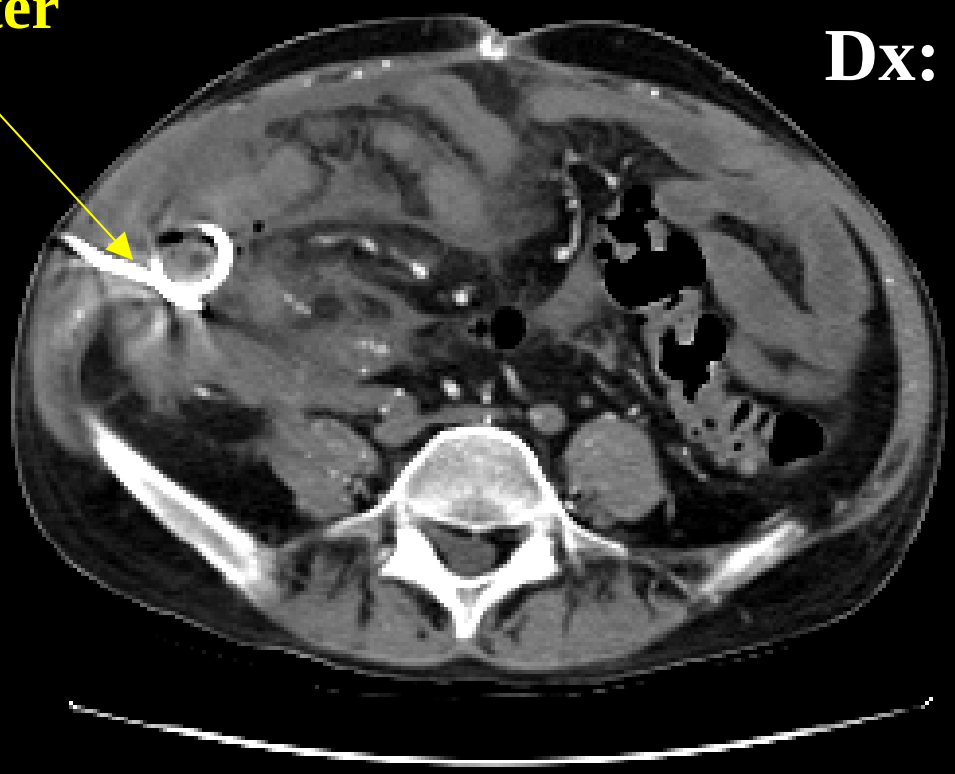
What can we do?

Drain the fluid with CT guidance!!

Pigtail Catheter



Fluid was purulent
Dx: Abscess

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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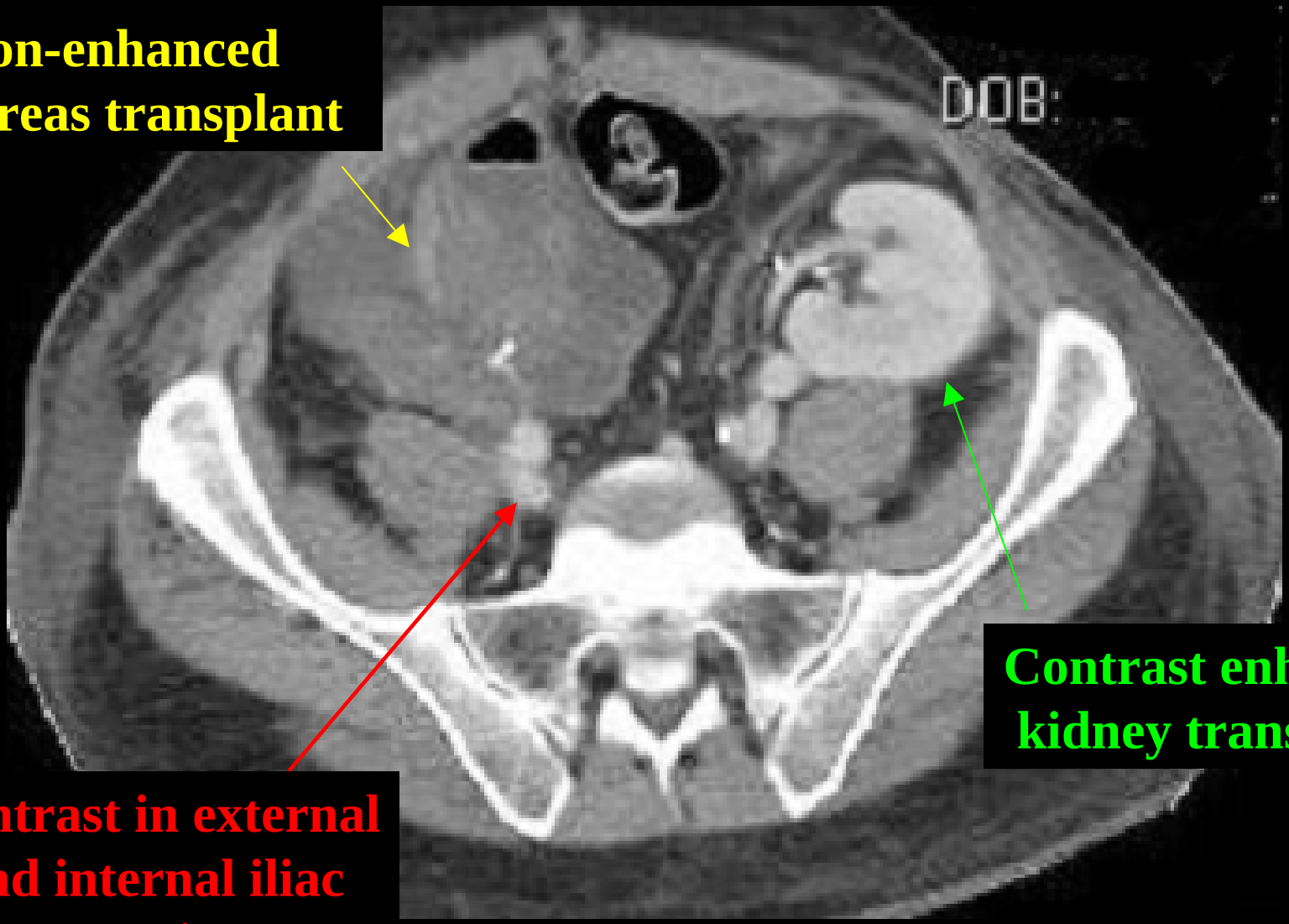
Demonstration of Pancreas Hypoperfusion on Arterial Phase of CT



Non-enhanced pancreas transplant

Contrast enhanced kidney transplant

Contrast in external and internal iliac arteries

Images Courtesy of Dr. Tkacz and Dr. Kruskal

Imaging technique: MRI

- Advantages
  - Excellent visualization of soft tissue structures
  - Effective alternative when difficult visualization by US or CT
  - Contrast enhanced MRA and MRI useful in assessment of vasculature
    - Useful in pts who had a poor US study and cannot have CT IV contrast (renal compromise)
    - Study by Boeve WJ et al. indicates efficacy of modality when compared to intra-arterial digital subtraction angiography
  - No radiation
- Disadvantages
  - Still undefined role in pancreatic transplant evaluation
  - Takes more time to image
  - Some patients are contraindicated for imaging

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Persistent Abdominal Pain and Inconclusive CT study

VIBE Sequence

Cecum
1) **Thick Walls**
2) **Hypointense periphery**

Suggestive of pneumatosis

NOT ALL POST-SURGICAL COMPLICATIONS INVOLVE THE PANCREAS

Images Courtesy of Dr. Tkacz and Dr. Kruskal

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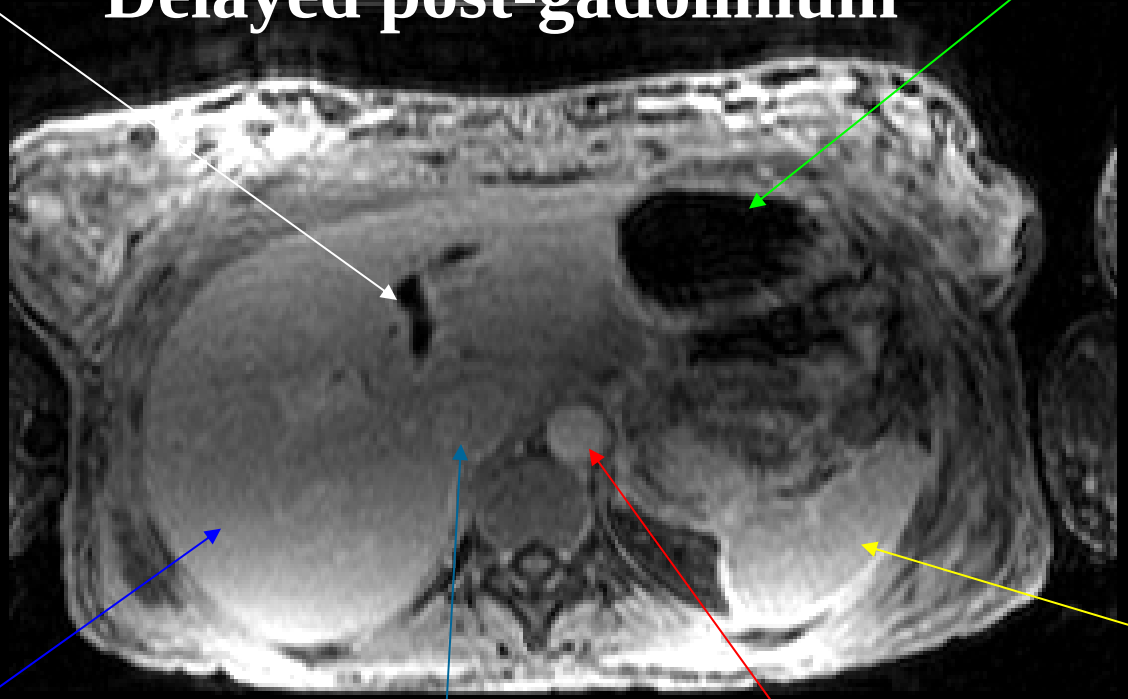
Persistent Abdominal Pain and Inconclusive CT study

**VIBE scan –
Delayed post-gadolinium**



Dx: Ascending Pyelophlebitis with Portal Vein Thrombosis

Images Courtesy of Dr. Tkacz and Dr. Kruskal

Diagnosis of Rejection

- Histopathologic by CT-guided or US-guided biopsy
- Chemical markers
  - SKP - ↑ serum Cre (Kidney function serves as proxy)
  - PTA vesical drainage - ↓ urinary amylase
  - PTA enteric drainage - ? ↑ blood glucose levels
  - ↑ serum amylase/lipase non-specific
- Imaging???
  - US: Resistive Index not proven to be effective
  - CT: No role
  - MRI: Dynamic contrast enhanced MRI: Krebs TL et al.

Percutaneous Biopsy

- Can be done with CT or US guidance
- Must consult and plan with transplant team
- 20g biopsy gun at more than one site
  - Possible differences in histology
  - Usually sample mid and proximal pancreas
- Post-biopsy complication of mild to moderate pancreatitis common

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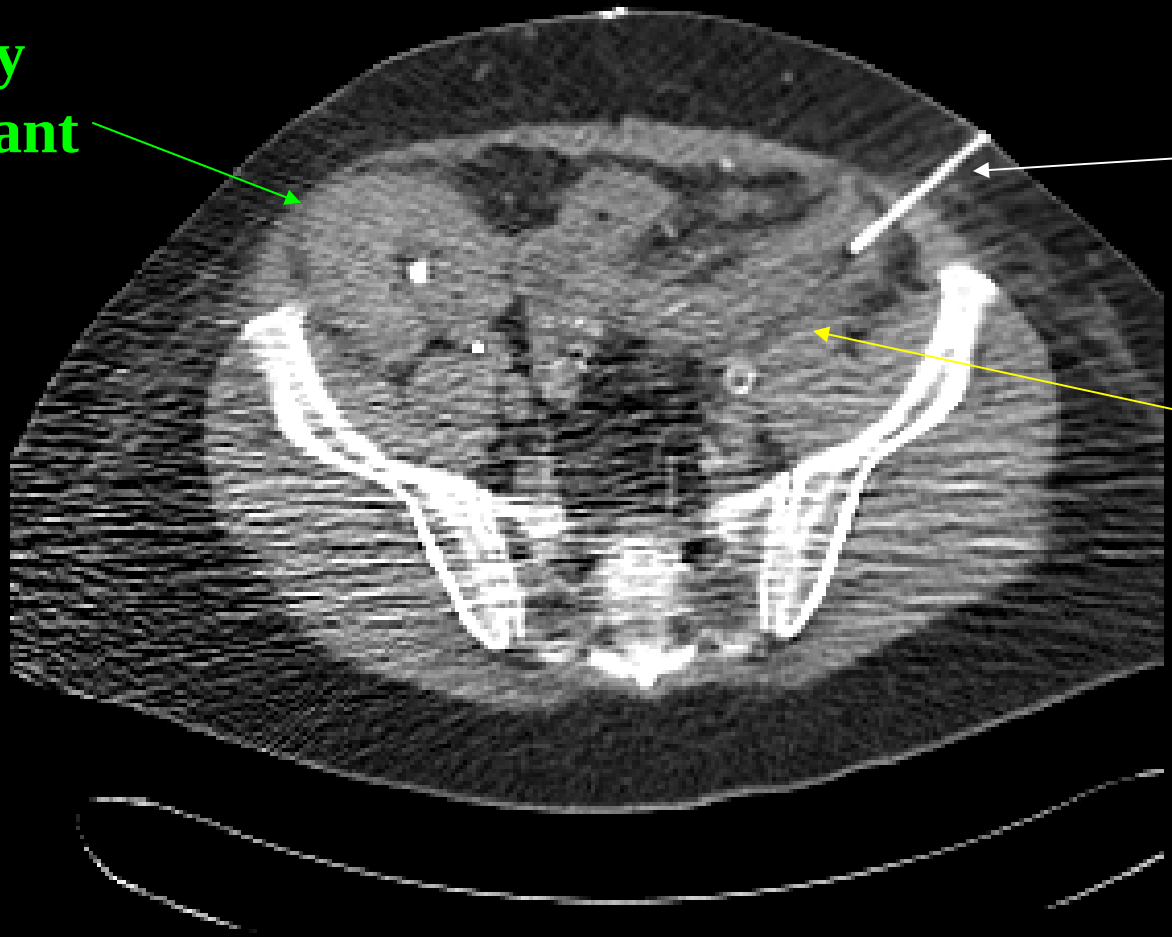
CT-guided Biopsy



Images Courtesy of Dr. Tkacz and Dr. Kruskal

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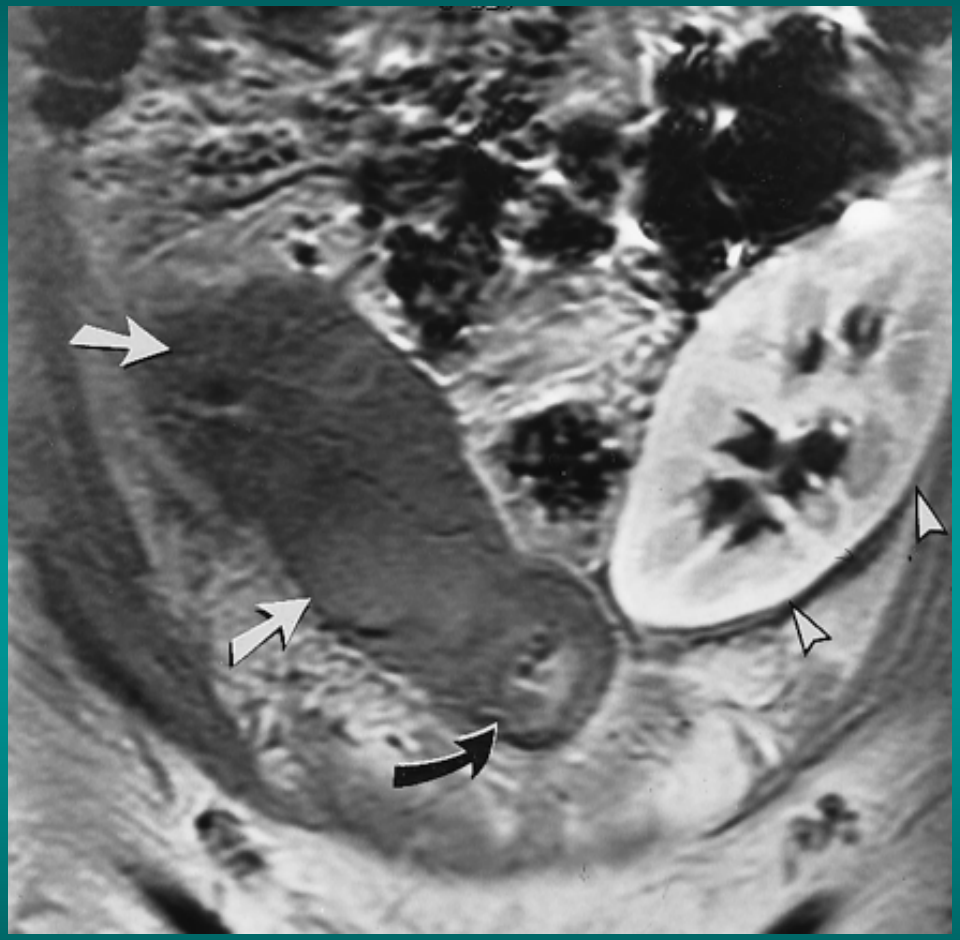
Comparison of Gadolinium-enhanced GRE MR

Viable Pancreas



Rejected Pancreas

Arrowheads: Kidneys Arrows: Pancreas Curved Arrows: Duodenal Stump

Krebs et al, Radiology (1999), Vol. 210(2), 437-442.

Dynamic Contrast-enhanced MRI Evaluation of Acute Rejection

- Mean percentage of parenchymal enhancement (MPPE) determined at 1 minute post-gadolinium load
- MPPE corresponded to histopathologic analysis
- Demonstrates decreased MPPE with rejection compared to viable transplant

Krebs et al, Radiology (1999), Vol. 210(2), 437-442.

Summary

- **Immediate Perioperative Evaluation of Symptomatic Patient**
  - US: Confirm vascular competency (r/o thrombus)
  - CT:
    - Complications of severe pancreatitis
    - Anastomotic leak
    - Fluid collections
  - MR: Evaluate inconclusive US and/or CT study
- **Rejection Evaluation**
  - CT or US guided biopsy
  - ? Utility of MR

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